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Five orders of Meteor Streams or Comets. By Richard A. Proctor.

The importance of Mr. Denning's discovery (which must now, I presume, be regarded as established), that the members of certain meteor systems radiate sometimes for months in succession from the same point in the star sphere, induces me to make some remarks upon the subject, with the view chiefly of recommending it to the attention of those who have time for the observation of meteors and shooting stars. I am the more disposed to do this because four or five years ago, when as yet Mr. Denning's discovery was not established, I pointed out the startling inferences deducible from it, as reasons for doubting—at that stage of his observations—whether the discovery could be real. Yet, fully twelve years ago, I had indicated a theory respecting the origin of comets and meteor-systems which would point to the belief that the relations resulting from Mr. Denning's discovery must in reality exist, startling though they are.*

It should not be necessary to state, in addressing the Fellows of the Astronomical Society, that Mr. Denning's discovery can bear but one interpretation. It proves that the motion of the Earth in her orbit round the Sun is almost at rest compared with the velocities of the members of those meteoric families which have an unchanging, or a very slightly changing radiant, for months in succession. Without assuming that the radiants can be determined with anything like the precision claimed by Mr. Denning (noticing indeed that if this were possible, then in the case of some meteor systems the effects even of our Earth's rotation could be detected in a change of radiant during a shower lasting five or six hours), it is certain that we have to deal, in the case of the long-lasting radiants, with bodies travelling at the rate of hundreds of miles per second. This is certain, without taking into account the effects of the Sun's attraction in modifying the direction of the movements of these meteors; but as a matter of fact the Sun's attraction cannot greatly alter (at the Earth's distance) the directions of bodies already moving with velocities far exceeding those he can impart. I have shown this mathematically in recent numbers of *Knowledge*, in which the simple but apparently little known mathematical relations involved have been somewhat fully dealt with.

Another point in Mr. Denning's discovery is also significant in the same direction. The point was not necessary to demonstrate what the discovery unquestionably proves; but it affords very interesting independent evidence. The meteors of the kind considered are seen year after year. Now this, which, in the case of systems observable only for a few hours or days at the outside, is a relation very naturally following from what is already known about such systems, has a very different meaning in the case of these meteors with long-lasting radiants. If the

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* In my article on "Three Orders of Comets," *Popular Science Review* for Jan. 1873.

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Earth passes one year through a meteor system attending on the Sun, she will pass through it, or at least through its orbit, every year. But meteors of the same system seen several months in succession manifestly cannot belong to a family attending on the Sun. Their being seen many years in succession indicates broad-spreading. It is an independent proof, therefore, of the remoteness of the source from which such meteors originally came.

As the new order of meteors detected by Mr. Denning cannot have been drawn to the solar system by the Sun's action, we must certainly reject in their case what some regard (strangely enough) as the accepted theory of meteoric origin,—I refer to Signor Schiaparelli's speculation that flights of scattered bodies are drawn into the solar system by the Sun's attraction, and are caused by planetary attractions to travel in closed orbits. I showed, twelve years ago, that this speculation undoubtedly fails also in the case of the November meteors, and probably for all meteor systems of that class. It was, however, never more than a speculation, and has always been so regarded by all who understand the matter, including those who have most admired the ingenuity displayed by Signor Schiaparelli in first suggesting, and afterwards enforcing, the theory of the connection between meteors and comets, which is now regarded as an established truth.*

But indeed to account for meteor-systems or comets as drawn from out the interstellar depths, is to explain *obscurum per obscurius.* It is antecedently altogether more unlikely (it is an infinitely wilder hypothesis, one may say) that the immensity of interstellar space should be a sort of breeding place for meteor flights, than that meteors should have had their origin in suns or planets. If an explosion like that of Krakatoa scatters earth-dust through millions of cubic miles of air (here I am in no sense adopting the Krakatoa explanation of the coloured sunsets, but simply referring to what certainly happened), the theory that a sunlike body—our Earth in her youth for instance—has expelled meteoric bodies in occasional eruptions through vast regions of interplanetary spaces, or that a Sun like our own has expelled meteoric bodies through yet vaster regions, is simply a theory which presents on a larger scale what we have already recognised as certainly happening on the smaller scale.

Apart from this, Signor Schiaparelli's speculation, after all, according to which meteor flights came from out the star depths, is by no means inconsistent with any theory showing how the meteor flights may have come into those depths.

Mr. Denning's discovery, since it presents meteor flights, or comets, traversing the interstellar depths with velocities far

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* As one of those who most earnestly advocated the recognition extended in 1872 to Signor Schiaparelli's theory, it should hardly be necessary for me to explain that what I have said in regard to his speculation has no reference to the validity of his theory.

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greater than our Sun can impart by his attractive might—compels us to recognise something more, in *these* meteor flights, any way, than mere space-begotten bodies. Must we not look for the source of these tremendous velocities, evidence as they are of tremendous energies exerted *somewhere*, to those bodies which are the mightiest we know of,—the giant suns?

In fine, I regard Mr. Denning's discovery as completing the evidence respecting comets which I presented in a comparatively incomplete state in my article on 'Three Orders of Comets,' in the *Popular Science Review* for January 1873. At that time I showed that we can recognise three orders of comets, viz.—*First*, those which, since they travel in paths passing near the paths, severally, of the giant planets, were probably ejected from those bodies when severally in the sunlike state; *secondly*, those which travelling in more widely extended paths, pass so near the Sun that they may be regarded as probably ejected from him, and subsequently so perturbed by planetary action as to pass clear of his globe on their return; and *thirdly*, those whose paths show that they were originally ejected from suns like ours. These three orders must now be regarded as respectively the *second*, *third*, and *fourth orders* of meteor flights or comets. Two other orders must be added, viz.:—*First*, those meteor systems whose paths or component elements show that the meteors were originally ejected from our Earth when she was in the sunlike state; and *fifthly*, those whose enormous velocities show that they were originally ejected, not from suns like our own, but from the giant suns like *Sirius*, *Vega*, *Altair*, and others, whose spectra indicate greater energies than exist in our own sun or his fellows,—as *Capella*, *Aldebaran*, *Betelgeux*, and other suns of Secchi's second class.

All that has been learned from the microscopical, chemical, and physical analysis of meteors, can be explained by the theory to which we have thus been led; and much of it can be explained no other way. Moreover, the observation of the Sun has demonstrated the occurrence of precisely such eruptions as this theory indicates.

To sum up, all or most meteor systems or comets would appear to have had their origin in orbs in the sunlike state, and may be classified under five heads, viz.:

First, those sprung from the terrestrial planets } when in the sunlike stage of their career.
Secondly, those sprung from the giant planets } when in the sunlike stage of their career.
Thirdly, those sprung from our own Sun.
Fourthly, those sprung from other suns of the same order.
Fifthly, those sprung from the giant suns of the first order.

Other classes probably exist, other sub-divisions certainly.

Galveston, Texas:
1885, *March* 31.

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A Peculiar Variety of Meteors. By W. F. Denning.

On the morning of April 20, at 1^{h} 36^{m} A.M., while watching the progress of the Lyrids I saw a remarkable meteor, projected apparently on the stars ϵ and δ of *Serpens*, as it rose upwards with great rapidity in the south. The meteor was about the third magnitude, but the singularity about it was its marvellous velocity and seeming nearness. It appeared to be in the air, a few yards distant, and I believe its path, extending (as it instantaneously impressed me) over some 16° on the background of the sky, must have been traversed in less than the twentieth part of a second. Of course there is a great difficulty in estimating such short intervals, but I feel confident the duration was even more transient than that assigned.

Now and then I have observed similar meteors before. They immediately strike one by their close proximity and enormous velocity. They are mere gleams of pale white light, which have little analogy to ordinary shooting stars, and suggest an electric origin, though I do not know whether the marvellous quickness with which they flash upon the eye is not to be held responsible for the sensation of nearness. They are somewhat rare, and one may watch through several whole nights without a single example, but, as far as my memory serves, I must have witnessed some scores of these meteoric flashes. I never register the paths; they are so rapid as to make but a vague impression on the retina, and the direction is necessarily much involved in doubt. As to the meteor of April 20, it ascended in *Serpens* from the western boundaries of *Scorpio*, and probably diverged from a radiant near the bow of *Sagittarius.* It was the only one I saw of the kind alluded to, or which could have belonged to a radiant so low in the S.E. amongst eighty-one meteors recorded during the nights of April 18, 19, and 20, 1885.

I have consulted several catalogues for notices of abnormal meteors such as the one described, but in most cases there is an absence of individual notes, and I have failed to gather much evidence of the kind required. But a most excellent instance, and I think the only one, is referred to in Col. Tupman's catalogue of nearly two thousand shooting stars observed by him while cruising in the Mediterranean during the years 1869–71. The particulars are:—

1870, January 9, 14^{h} 59^{m}; mag. 3; path from $169°+20°$ to $157°-10°$; length 31°; duration 0·1 second. "An instantaneous flash; seemed to be in the air, quite near. Very curious."

It will be seen that Col. Tupman's description is very similar to my own. Though his meteor had a path of no less than 31°, he estimated the duration as only the tenth of a second.

On the whole I incline to the belief that meteors of this abnormal class give the idea of great nearness as the result of their astonishing speed, and that they will be invariably found